

Capital Expenditures for Manufacturing Plant and Equipment—1915 to 1940¹

By Lowell J. Chawner, Chief Industrial Economist

THE production of manufacturing capital facilities in the form of plant and equipment, for both public and private ownership, in the United States during the first 3 months of 1941 will exceed that of any previous quarter year in our history. If no appreciable decline occurs from the present rate (a slight increase during the second and third quarters seems more likely in terms of the present outlook), the total production of new manufacturing facilities in 1941 may reach \$3.5 billion. The corresponding value is estimated to have been \$2.3 billion in 1940, \$2.7 billion in 1929, \$3.2 billion in 1920, and \$2.5 billion in 1918 at the peak of our productive effort during the first World War. These figures are in current prices of the year during which the expenditures were made, and hence exaggerate the fluctuations in the actual physical additions to productive capacity. After allowances for price changes, gross additions to manufacturing plant and equipment appear to have been approximately the same in the three peak years 1918, 1920, and 1929, but less than that in prospect for 1941.²

This article endeavors to summarize the broad general movements which have occurred during the past 25 years in the additions to manufacturing capital facilities. The record of these expenditures during the World War and subsequent years has a timely bearing upon the development of national policy, both by private enterprises and by the Government, with regard to the increases in capital facilities required to attain the large, and for the most part highly specialized, production necessary in the present emergency. A careful study of our experience over this period also will throw light upon the character and magnitude of the readjustment of productive facilities which may be expected following a decline in national defense expenditures.

Estimates of capital expenditures for manufacturing purposes for plant and equipment by quarters from 1915

to 1940 are shown in table 1.³ The terms "capital expenditures" and "capital assets" as used here follow the usual definitions of business accounting rather than those of economic theory. They consequently refer for the most part to durable producers' goods, usually those having a useful life of 3 years or more, upon which annual depreciation charges are made, rather than to all commodities retained for multiple use in the production

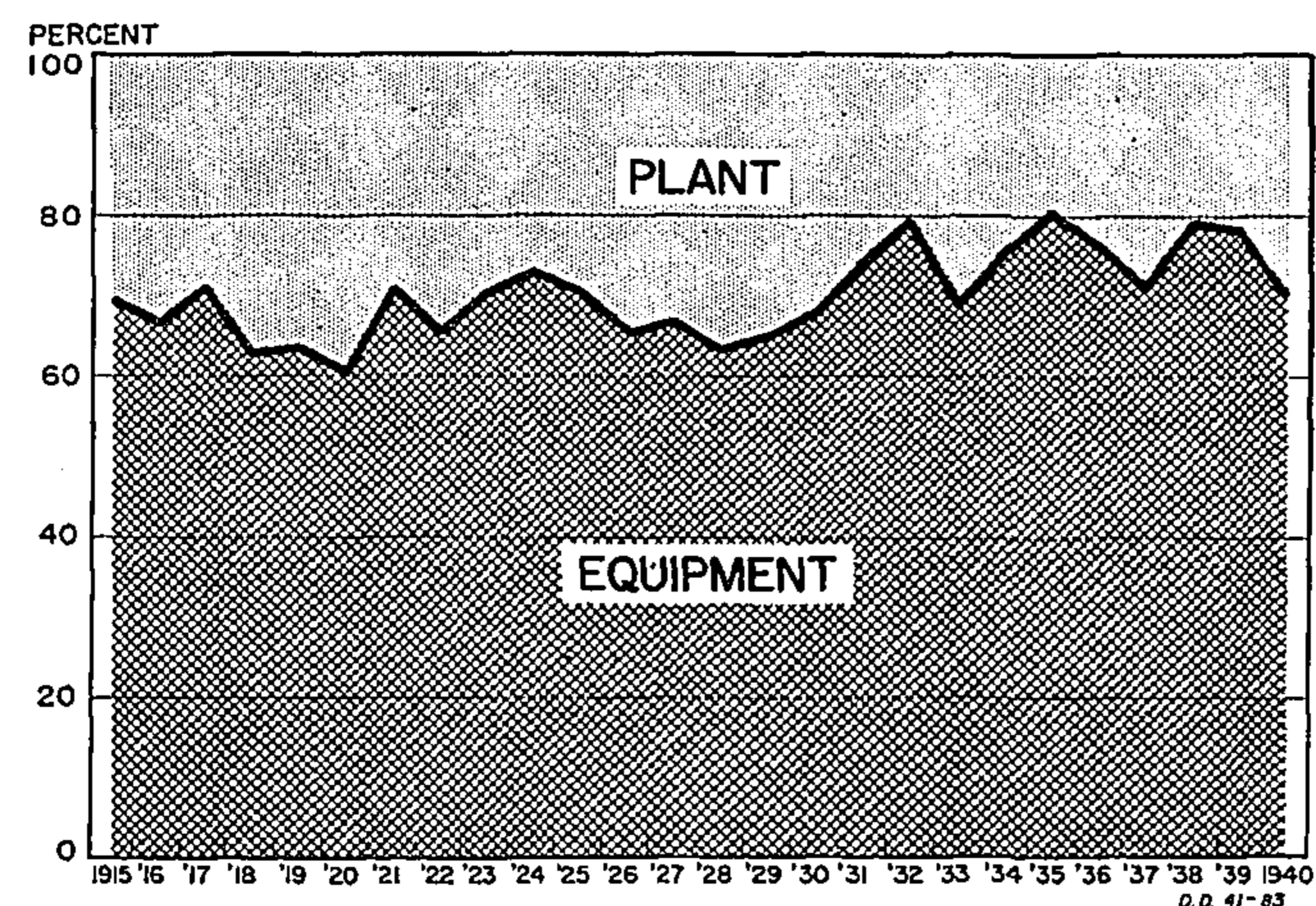


Figure 4.—Percentages Which Plant and Equipment are of the Total New Manufacturing Capital Expenditures, 1915-40 (Based upon the Estimates Shown in Table 1).

of other goods and services. These estimates consequently do not include expenditures for small cutting tools and hand tools nor expenditures for the maintenance and minor repairs of structures or machinery. In calculating the estimates, allowances were made for the actual cost of plant and equipment to the manufacturing concerns using it, thus including distribution, transportation, and installation costs. They also include deductions for exports and allowances for imports at their final cost to the industrial user.⁴

³ The separate classifications of plant and equipment are similar to those used in the enumeration of such expenditures recently made by the Bureau of the Census for all active manufacturing establishments in 1939. When tabulated, this enumeration will provide the first direct measure of such expenditures by manufacturing concerns in the United States.

⁴ Annual estimates of the production of all types of durable goods for producers and consumers for 1919 and subsequent years have been made by George Terborgh (Federal Reserve Bulletin, September 1939 and February 1941) and by Simon Kuznets (Commodity Flow and Capital Formation). However, separate estimates for manufacturing capital expenditures apart from those for mining and other industries have not been compiled by them. Using sample data secured from manufacturers responsible for 1.3 percent of the total manufacturers' sales in 1936, Dun and Bradstreet Incorporated have estimated that the total expenditures for improvements and enlargements by manufacturing concerns were \$1.5 billion in 1936 and \$1.8 billion in 1937 (Dun's Review, July 1938).

¹ The material in this issue includes a new series of quarterly estimates of capital expenditures of manufacturing concerns for plant and equipment from 1915 to 1940 and a discussion of the principal influences related to such expenditures. A discussion of capital expenditures in individual industries and geographic regions will appear in a subsequent issue. Dorothy S. Coleman assisted greatly in the statistical research and direction of the calculations involved in the preparation of these estimates.

² These comparisons of capital expenditures over a number of years should be contrasted with the growth in population and output of manufactured products over the same period. Between 1915 and 1940, population in the continental United States increased slightly more than 32 percent, while the trend of manufacturing output rose at approximately twice this rate.

Movement of Total Capital Expenditures

During the years of the first World War, capital expenditures for manufacturing facilities, both public and private, at current prices, increased from approximately \$620 million in 1915 to \$2,466 million in 1918. These expenditures may be compared with an estimated net value of manufacturing plant and equipment assets of approximately \$10 billion at the beginning of this period.

The amounts of the Federal Government outlays for productive facilities, as distinguished from other expenditures, cannot be determined precisely. It appears, however, that manufacturing facilities for public ownership by the War Department, the Navy Department, the Emergency Fleet Corporation, and other Federal agencies were constructed during the fiscal years 1917, 1918, and 1919 at a cost of approximately \$500 million. This amount does not include the privately owned plants which were built for the primary purpose of producing military supplies and which for all practical purposes were thus financed by the Government.

During the two immediate post-war years the gross additions to manufacturing facilities remained high; and the expenditures of \$3.2 billion upon plant and equipment in 1920 have not been equaled before or since that time. This large volume was due to the

rapid readjustment of manufacturing facilities to peacetime purposes, particularly in the metal-working and automobile industries, and also reflected the sharply rising prices during these years.

Large physical additions to manufacturing plants, measured by floor space of new manufacturing buildings constructed, were made throughout the entire period from 1916 to 1920, as indicated in table 2. Annual equipment expenditures adjusted for price changes also were very large and did not change greatly during the entire 4 years 1917 to 1920 inclusive. Statistics on railroad shipments of machinery over this period tend to further substantiate this observation. Annual estimates of capital expenditures for manufacturing purposes from 1915 to 1940, adjusted for price changes, appear in table 3.

Several influences tended to sustain manufacturing plant and equipment expenditures at fairly high levels during all but two of the immediate post-war years. The need for readjustment of our wartime economy to meet peacetime requirements, together with the provisions of the Revenue Act of 1918, which made it possible for concerns to depreciate rapidly all wartime equipment, resulted in very substantial capital expenditures during 1919 and 1920, as already observed. A sharp decline in 1921 and little change in 1922 was followed by 8 years of substantial and usually slightly increasing expenditures upon replacements and expan-

Table 1.—Estimates of New Manufacturing Capital Expenditures for Plant and Equipment in the United States, by Quarters, 1915-40

[Millions of dollars—in current-year prices]

Year and quarter	Plant	Equip-ment	Total	Year and quarter	Plant	Equip-ment	Total	Year and quarter	Plant	Equip-ment	Total	Year and quarter	Plant	Equip-ment	Total
1915:				1922:				1929:				1936:			
1st quarter....	33	94	127	1st quarter....	97	213	310	1st quarter....	233	426	659	1st quarter....	72	264	336
2d quarter....	37	101	138	2d quarter....	107	237	344	2d quarter....	248	405	713	2d quarter....	91	287	378
3d quarter....	52	109	161	3d quarter....	149	258	407	3d quarter....	234	448	682	3d quarter....	100	290	390
4th quarter....	66	124	190	4th quarter....	180	301	481	4th quarter....	247	438	685	4th quarter....	110	331	441
Year.....	188	428	616	Year.....	533	1,009	1,542	Year.....	962	1,777	2,739	Year.....	373	1,172	1,545
1916:				1923:				1930:				1937:			
1st quarter....	77	152	229	1st quarter....	154	341	495	1st quarter....	212	388	600	1st quarter....	125	377	502
2d quarter....	81	165	246	2d quarter....	173	383	556	2d quarter....	141	359	500	2d quarter....	151	402	553
3d quarter....	95	175	270	3d quarter....	168	356	524	3d quarter....	146	289	435	3d quarter....	179	389	568
4th quarter....	96	211	307	4th quarter....	118	357	475	4th quarter....	117	256	373	4th quarter....	171	366	537
Year.....	349	703	1,052	Year.....	613	1,437	2,050	Year.....	616	1,292	1,908	Year.....	626	1,534	2,160
1917:				1924:				1931:				1938:			
1st quarter....	112	273	385	1st quarter....	128	350	478	1st quarter....	83	220	312	1st quarter....	87	305	392
2d quarter....	117	295	412	2d quarter....	115	332	447	2d quarter....	76	216	292	2d quarter....	66	264	330
3d quarter....	141	319	460	3d quarter....	111	277	388	3d quarter....	64	174	238	3d quarter....	68	258	326
4th quarter....	135	344	479	4th quarter....	117	301	418	4th quarter....	50	162	212	4th quarter....	70	275	345
Year.....	505	1,231	1,736	Year.....	471	1,260	1,731	Year.....	273	781	1,054	Year.....	291	1,102	1,393
1918:				1925:				1932:				1939:			
1st quarter....	176	378	554	1st quarter....	135	336	471	1st quarter....	38	146	184	1st quarter....	66	278	344
2d quarter....	273	398	671	2d quarter....	135	342	477	2d quarter....	29	117	146	2d quarter....	78	298	376
3d quarter....	289	395	684	3d quarter....	150	334	484	3d quarter....	25	95	120	3d quarter....	94	293	387
4th quarter....	181	376	557	4th quarter....	165	372	537	4th quarter....	26	98	124	4th quarter....	104	361	465
Year.....	919	1,547	2,466	Year.....	585	1,384	1,969	Year.....	118	456	574	Year.....	342	1,230	1,572
1919:				1926:				1933:				1940:			
1st quarter....	145	339	484	1st quarter....	189	392	581	1st quarter....	25	92	117	1st quarter....	112	372	484
2d quarter....	131	298	429	2d quarter....	201	392	593	2d quarter....	45	100	145	2d quarter....	127	384	511
3d quarter....	221	345	566	3d quarter....	205	370	575	3d quarter....	79	144	223	3d quarter....	166	415	581
4th quarter....	318	427	745	4th quarter....	220	381	601	4th quarter....	75	157	232	4th quarter....	279	448	727
Year.....	815	1,409	2,224	Year.....	815	1,535	2,350	Year.....	224	493	717	Year.....	684	1,619	2,303
1920:				1927:				1934:							
1st quarter....	394	477	871	1st quarter....	184	377	561	1st quarter....	56	168	224				
2d quarter....	390	500	890	2d quarter....	168	367	535	2d quarter....	59	195	254				
3d quarter....	266	511	777	3d quarter....	173	334	507	3d quarter....	59	175	234				
4th quarter....	199	428	627	4th quarter....	177	328	505	4th quarter....	63	175	238				
Year.....	1,249	1,916	3,165	Year.....	702	1,406	2,108	Year.....	237	713	950				
1921:				1928:				1935:							
1st quarter....	136	307	443	1st quarter....	185	339	524	1st quarter....	46	208	254				
2d quarter....	91	260	351	2d quarter....	198	359	557	2d quarter....	54	223	277				
3d quarter....	88	211	299	3d quarter....	239	362	601	3d quarter....	61	239	300				
4th quarter....	81	193	274	4th quarter....	229	395	624	4th quarter....	66	260	326				
Year.....	396	971	1,367	Year.....	851	1,455	2,306	Year.....	227	930	1,157				

Source: Compiled by U. S. Bureau of Foreign and Domestic Commerce. See description of estimates at end of this article.

sion in manufacturing facilities of approximately 2 billion dollars annually. The rapid expansion in demand for several relatively new products such as automobiles, electrical household appliances, and synthetic chemicals, together with the large additions to generating and distribution facilities of electric light and power concerns, a residential building boom, and the construction of an extensive highway system throughout the United States, all contributed to this development. The migration of cotton textile mills to the South Atlantic States, and the exploitation of petroleum resources in the South Central States and in California and other Western States resulted in substantial expenditures for refining and other manufacturing facilities in these areas. Throughout this period, far-reaching improvements occurred in machines and in the technical organization of manufacturing processes. The post-war decade, with the exception of 1921, also was a period of well-sustained earnings of manufacturing concerns which provided both the means and incentive for further plant expansion.

Table 2.—Estimated New Floor Space of Manufacturing Buildings, by Years, 1915-40

[Millions of square feet]

Year	Floor space	Year	Floor space	Year	Floor space
1915.....	90	1925.....	98	1935.....	31
1916.....	160	1926.....	112	1936.....	59
1917.....	180	1927.....	107	1937.....	98
1918.....	300	1928.....	135	1938.....	43
1919.....	210	1929.....	160	1939.....	62
1920.....	250	1930.....	97	1940.....	121
1921.....	70	1931.....	37		
1922.....	100	1932.....	17		
1923.....	110	1933.....	28		
1924.....	77	1934.....	28		

Source: Based on F. W. Dodge Corporation reports and other data. See description of estimates at end of this article.

In 1931, manufacturing capital expenditures declined sharply to an amount less than that of any year since the World War, and they remained low during the subsequent 4 years. Although the rate of new capital expenditures upon plant and equipment during the 1930 decade has been very low, considerably less than the attrition of capital measured by depreciation and obsolescence, the additions to facilities that have been made, particularly during the past few years, are in many cases technically more efficient per dollar value of capital investment than similar equipment was a decade or more ago. Also during this period actual retirements appear to have been less than the depreciation taken upon capital plant and equipment. Consequently, the physical productive capacity of many manufacturing industries has been maintained more adequately than is indicated by a comparison of capital expenditures with depreciation and obsolescence charges.

The present emergency, which requires a greatly increased production of many commodities in the interest of national defense, comes at a time when a number of manufacturing concerns appeared to be

initiating plans for considerable plant expansion, improvement, and relocation to meet their normal requirements. Marked improvements have been effected in mechanical devices and in environmental conditions for efficient production by industrial workers such as those in plants built during the past 2 years for the Simonds Saw & Steel Co. and the Allison Division of the General Motors Corporation. The relocation of many industrial establishments in areas more favorably situated than existing sites from the point of view of proximity to markets and raw materials, to electric power and other energy resources, and to more favorable living conditions for industrial workers, also appear to have been possible. Some expansion of this character may occur in plant additions to meet defense needs. In many cases, however, it appears that current additions to manufacturing facilities must be provided in the most expeditious manner to assure at the earliest possible moment the products required for the national defense rather than to expand the facilities entirely from the point of view of maximum economic efficiency. Many of the principal designers of manufacturing plants report that in recent months some of their clients have deferred plant expansion for other than defense purposes. Consequently, it is possible that

Table 3.—Estimate of New Manufacturing Capital Expenditures for Plant and Equipment, 1915-40, in 1939 Prices

[Millions of dollars]

Year	Capital expenditures adjusted for price changes			Year	Capital expenditures adjusted for price changes		
	Plant	Equipment	Total		Plant	Equipment	Total
1915.....	302	736	1,038	1928.....	746	1,516	2,262
1916.....	485	1,098	1,583	1929.....	851	1,832	2,683
1917.....	594	1,558	2,152	1930.....	576	1,452	2,028
1918.....	956	1,594	2,550	1931.....	280	930	1,210
1919.....	715	1,380	2,095	1932.....	142	577	719
1920.....	953	1,791	2,744	1933.....	262	624	886
1921.....	341	961	1,302	1934.....	266	792	1,058
1922.....	489	1,147	1,636	1935.....	255	1,045	1,300
1923.....	524	1,545	2,069	1936.....	397	1,317	1,714
1924.....	406	1,339	1,745	1937.....	626	1,565	2,191
1925.....	513	1,472	1,985	1938.....	291	1,114	1,405
1926.....	728	1,634	2,362	1939.....	342	1,230	1,572
1927.....	610	1,479	2,089	1940.....	671	1,587	2,258

Source: The estimates shown in table 1 were adjusted for price changes using appropriate indexes of actual costs of "shop machinery," "shops and engine houses," and similar items compiled by the Bureau of Valuation of the Interstate Commerce Commission.

after the needs of the present emergency have been met, there may be a tendency toward the readjustment of our fundamental industrial facilities similar to that which occurred after the first World War. The extent to which such a readjustment may actually occur will be influenced not only by the then current demand for manufactured products but also by factors such as the movement of population, incentives or deterrents to technological change, and by tax and other public policies relating to capital investment.

Capital Consumption

The attrition of capital assets in the form of plant and equipment may be accounted for by (a) deprecia-

tion and obsolescence charges, (b) capital losses through revaluation of assets arising from changes in earning power, and (c) capital losses through destruction of plant and equipment, partial or complete, by catastrophes such as fire, tornado, or flood.

By far the largest form of capital consumption in the aggregate is taken as depreciation and obsolescence charges. Charges to depreciation and similar accounts may be more or less than the actual loss of value or usefulness for productive purposes of capital assets. Some concerns not infrequently fail to provide adequate reserves against the loss of value of their capital assets, although their accounts may not indicate this to be true. Other concerns undoubtedly have fully depreciated certain capital assets that have not been retired and still possess substantial value in use. Notwithstanding these differences, depreciation charges do provide a rough measure of the year-to-year change in the principal element in the consumption of capital

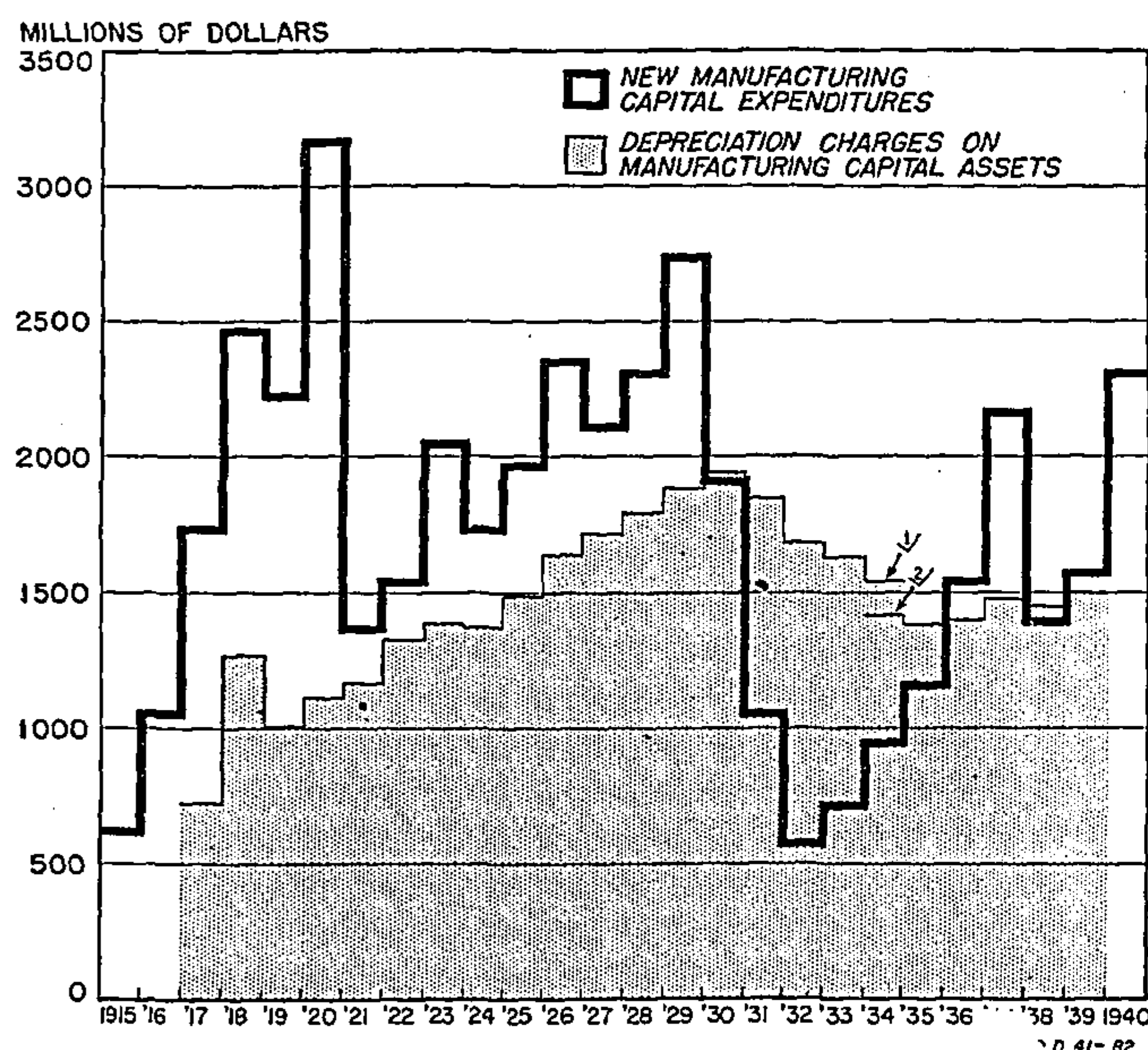


Figure 5.—New Manufacturing Capital Expenditures for Plant and Equipment and Current Depreciation Charges on Manufacturing Capital Assets, 1915-40.

NOTE.—Both series refer to all manufacturing concerns, corporate and unincorporated. New manufacturing capital expenditures, U. S. Bureau of Foreign and Domestic Commerce (see table 1). Depreciation, including obsolescence charges of manufacturing concerns, years 1919 to 1935, from "Capital Consumption and Adjustment," National Bureau of Economic Research (Fabricant); years 1917, 1918, 1936, and 1937 derived from U. S. Bureau of Internal Revenue data; years 1938 and 1939 derived from the "Survey of American Listed Corporations," Securities and Exchange Commission. Data for 1915, 1916, and 1940 are not available. See accompanying text for a discussion of the limitations involved in the comparison of these two series.

¹ Data are from consolidated corporation returns and are comparable with those for prior years.

² Data are from unconsolidated corporation returns and are comparable with those for subsequent years.

assets corresponding to the increments in such assets measured by capital expenditures shown in table 1. Similarly, estimates of new plant and equipment produced may include some machinery which is not treated as capital by some manufacturing concerns but is charged as current operating expense during the year in which it is purchased.

The capital expenditures and depreciation charges shown in figure 5 provide the basis for an approximate comparison of the increases and decreases in useful capital facilities from year to year. The comparison is a rough one, and in its interpretation the following facts should be fully recognized. The expenditure figures in 1918, 1919, and 1940 include substantial amounts for facilities financed by the Federal Government. The corresponding depreciation charges refer only to privately owned plants. The depreciation charges during the first few years shown on the chart relate largely to capital assets which cost much less per comparable unit than the facilities that were added during the years 1917 through 1920. Moreover, since the figures for expenditures and for depreciation do not cover precisely the same items, the relative heights of the two curves are not strictly comparable.

Notwithstanding these important differences, a comparison of the two curves since 1921 is believed to be an approximately valid one. In each year prior to 1930, there appears to have been a slight net addition to manufacturing capital. Since 1930, however, the attrition of capital in each year, with the exception of 1936, 1937, 1939, and 1940, has been more than the current additions to capital facilities during these years.

Economic Analysis of Manufacturing Capital Expenditures

In view of the marked differences which occur in the rate at which outlays are made for plant and equipment in particular industries, any adequate economic analysis of manufacturing capital expenditures must include an appraisal of these expenditures in different industries. Such an appraisal would be largely in terms of technological developments in new products and processes of manufacture, current production and its relation to productive capacity, the earnings of the leading concerns, and other similar factors in each industry.

However, it is also interesting to consider the fluctuations of manufacturing capital expenditures as a whole in terms of the more general factors related to these movements. The principal influences which might appear to be related to aggregate manufacturing capital expenditures are total manufacturing production, total profits of manufacturing enterprises, interest rates, factory construction costs, the attitude of business enterprisers with regard to the outlook for the future, broad general shifts in the markets for manufactured products and extensive changes in the demand for manufactured products such as those occurring in time of war.

From 1916 to 1920, and during the past few months, marked changes in the character of products of manufacturing industries needed to meet military requirements have largely determined the character of plant expansion. From 1916 to 1920, surprisingly little change occurred in the total physical volume of manu-

facturing production. In those years, however, and again since last June, our requirements for the production of military airplanes, powder, guns, shells, and ships increased at a striking rate over the immediately preceding period.

On figure 6 are shown indexes of the new manufacturing capital expenditures for plant and equipment, the physical volume of manufacturing production, and the net profits, after all taxes, of manufacturing concerns having net earnings. There is general agreement, as logically would be expected, between the fluctuations in additions to manufacturing facilities and those in the physical volume of the manufacturing production. The movement in capital expenditures also appears to be quite similar to that in the net profits of manufacturing concerns having net earnings in a given period. This similarity does not mean that the concerns which are more profitable are necessarily the ones which are responsible for capital expenditures. A concern that is not relatively as profitable as its leading competitor

may add to or improve its facilities in order that it may compete more effectively.

The precise nature of the relationship between manufacturing capital expenditures and net profits is not well defined and cannot be determined using time series of aggregate data such as are shown in figure 6. Nevertheless, it is interesting to observe that there is a closer similarity in the movements of the two series during the past 18 years than between total manufacturing capital expenditures and any other related factor for which data are available. The sharp rise in additions to capital facilities during the last half of 1940 is an exception to this general observation because of the fact that possibly as much as 20 percent of the expansion of facilities in this period, both publicly and privately owned, is required for defense-production purposes. At present this percentage is considerably higher.

It may also be observed that careful study indicates that changes in interest rates and in factory building costs over the past 25 years did not bear any simple or direct

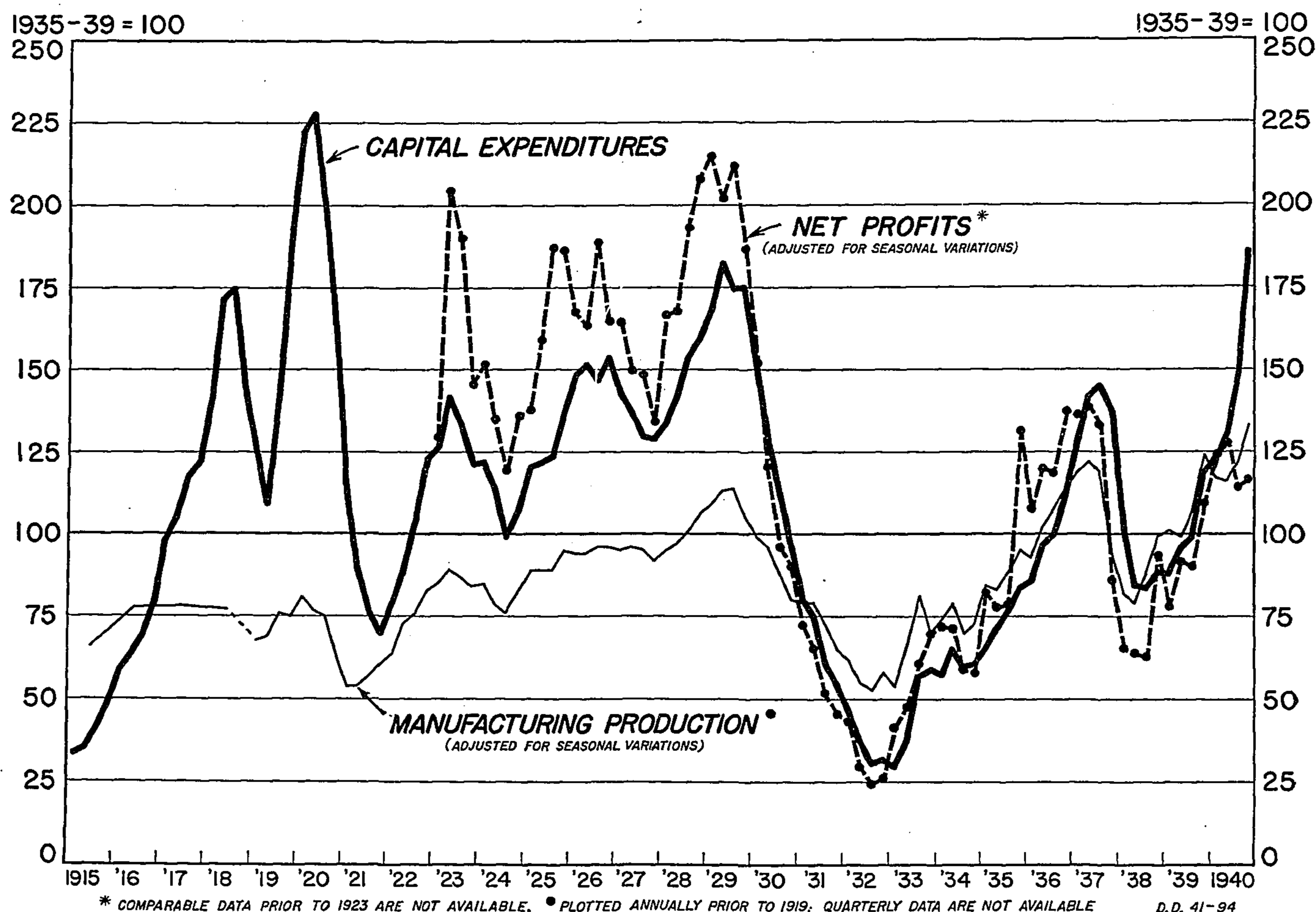


Figure 6.—Indexes of Value of New Manufacturing Capital Expenditures for Plant and Equipment, Physical Volume of Manufacturing Production, and Net Profits (After All Taxes) of Manufacturing Concerns, by Quarters, 1915-40.

NOTE.—New manufacturing plant and equipment expenditures based upon table 1. Physical volume of manufacturing production from 1919 to 1940, Board of Governors of the Federal Reserve System and from 1915 to 1918, "The Output of Manufacturing Industries," National Bureau of Economic Research (Fabricant). Net profits of manufacturing concerns (after all taxes) derived by the U. S. Bureau of Foreign and Domestic Commerce from data compiled by the U. S. Bureau of Internal Revenue and the Federal Reserve Bank of New York. Estimates are based upon data showing the aggregate profits of concerns having net earnings. The estimated net profits include allowances for the trend in the relative contribution of corporate and unincorporated concerns and allowances for major breaks in the statistics of corporate incomes including the change from consolidated to unconsolidated returns in 1934.

relation to the movement of total capital expenditures for manufacturing purposes. In fact, quarterly time series for capital expenditures are positively correlated with similar series for interest rates and building costs.⁵ However, fluctuations in interest rates and building costs, particularly those that are sharp and abrupt, undoubtedly have substantial effects upon projected expenditures for plant expansion by individual concerns. As indicated above, economic analysis of manufacturing capital expenditures must be sought principally in terms of individual industries and enterprises rather than in terms of broad general movements for manufacturing as a whole.

Productive Facilities for the National Defense

The total expenditures upon manufacturing facilities financed directly by the Federal Government under the present defense program are much larger than similar expenditures during the first World War. As has been indicated the expenditures for these purposes by the Army, the Navy, the Emergency Fleet Corporation and other Government agencies appear to have been approximately \$500 million during the fiscal years 1917 to 1919, inclusive.⁶ Since June 1940, the funds which have been made available for investment in productive facilities by the various agencies of the Federal Government total approximately \$1,900 million. This amount includes funds provided in specific appropriations to the Army, the Navy, and the Maritime Commission plus actual contracts which have been entered into by the Reconstruction Finance Corporation and the Defense Plant Corporation. In view of the large expansion possible in the allocation of the resources of these corporations for productive facilities under existing law, the total amounts which eventually may be allocated by them for manufacturing plant and equipment cannot be determined. Also, the enactment of appropriations now pending before the Congress including those to implement the Lease-Lend Act, very likely will add several hundred million dollars to the funds now available for investment in plant facilities by the Federal Government.

Of the total indicated above \$1,574 million were

under contract or letter of intent on March 1, 1941. Approximately two-thirds of these contracted expenditures are for facilities which are financed entirely, and presumably will be owned permanently by the Federal Government. The remainder are for facilities for which the various agencies of the Federal Government assume an obligation to pay their entire cost because of their immediate need for defense purposes, but which also are considered to be of possible commercial value later in fabricating goods for civilian use. The contracts for the construction of these plants contain an option for the purchase by the private operating agency of any equity which the Government may have in such a facility at the termination of the contract between the agency and the Federal Government.

A small part, possibly not more than 10 percent, of the total indicated as having been placed under contract represents actual purchases of machinery or construction of plants during the calendar year 1940. Also some of the contracts may not be fully executed during the present year. By far the largest part of these totals, however, represent expenditures to be made for plant and equipment during 1941.

In addition to these projects financed by the Federal Government a large number of plants have been built and financed entirely by private concerns for national defense purposes. Under the Second Revenue Act of 1940 concerns constructing facilities which are considered by the appropriate authorities to be necessary in the national defense may be permitted to depreciate them over a period of five years in the calculation of their taxable income. The Office of Production Management reports that "certificates of necessity" have been issued up to March 1, 1941, for the construction of plants which will cost \$393 million. It also reports that the British Government since June 1, 1940, has undertaken to finance the expansion of productive facilities in the United States at a cost of \$171 million.

The smooth working of a society dependent upon intricate and highly specialized industrial facilities requires not only great technical skill but also careful economic preparation for the introduction of such facilities many months in advance of their actual use. This fact is now realized in its relation to the present defense program. It is equally pertinent to the adjustment which appears likely to follow the curtailment of defense production and merits the most careful consideration by private and governmental agencies concerned with such problems.

⁵ Fluctuations in interest rates and building costs exercise a greater influence on outlays for types of improvements and construction such as houses and office buildings in which the capital cost is a large part of the total cost of ownership and operation.

⁶ Many of the facilities required to meet our war needs were constructed and substantially written off out of the profits of the business for the Allies prior to the entrance of the United States into the War in April 1917. See "The Costs of the World War to the American People," by John Maurice Clark.

Description of Estimates of Manufacturing Capital Expenditures

Equipment Expenditures.

The estimates of equipment expenditures include such items of specialized industrial machinery as leather-working, metal-working, rubber-working, textile, and similar machinery, and general-purpose equipment such as electric motors, steam, Diesel, and other prime movers, cranes, trucks, office fixtures, business machines and other movable equipment.

These estimates are based upon the value of production reported in every Census year from 1914 to 1939 for each of approximately 65 major groups of industrial machinery and related equipment used for manufacturing purposes. Prior to 1923, data are available for a somewhat smaller number of industrial-machinery products. A comparable series for all of the Census years during the entire period from 1914 to 1939 was secured by making allowances derived for the few unreported items from a careful examination of the Census statistics for each machinery product in every Census year.

More than half of the industrial-machinery products for which biennial Census data are available (such as textile, shoe, rubber-working, and flour-mill machinery) are used entirely in particular industries. Production of such special-purpose machinery constitutes approximately 60 percent of the total industrial machinery estimated to have been used for manufacturing capital purposes. A number of other capital equipment items, such, for example, as "steam engines and turbines (excluding marine)" and "electric motors, 1 horsepower and over (not including railway and automotive)," are used largely but not entirely for manufacturing purposes. The proportion of these products that was estimated to have been used for manufacturing capital purposes was based on data obtained from trade associations and technical specialists in the various machinery industries.

For 1923 and subsequent years, quarterly estimates of industrial-machinery production were interpolated between the data for Census years by using a quarterly index of pay rolls of industrial-machinery manufacturers derived from data compiled by the Bureau of Labor Statistics. This index of pay rolls was based upon the following five series: Electrical machinery; engines, turbines, etc.; machine tools; textile machinery; and foundry and machine-shop industries—weighted from year to year according to the proportion which the industrial-machinery production of these industries was of the totals of all industrial-machinery production in that year. The pay-roll index used from 1919 to 1922, inclusive, is that for all machinery industries (not including transportation equipment) compiled by the Federal Reserve Board. (Federal Reserve Bulletin, December 1923.)

Estimates for intercensal years between 1914 and 1919 were derived by using annual reports from 5 States—Massachusetts, New York, New Jersey, Pennsylvania, and Missouri. The industrial-machinery products reported for these 5 States comprised approximately 40 percent of the United States totals for these products for the year 1919. The quarterly movement from 1914 to 1919, which approximates a straight line, is based upon an index of machinery-manufacturing pay rolls for New York State. In all cases throughout the entire period, the movement in the quarterly series was adjusted to equal the movement in the production of industrial machinery between Census years.

Deductions for exports were made from the quarterly estimates of the production of industrial machinery for manufacturing-capital purposes. These deductions were based upon a detailed compilation of the exports of commodities as nearly identical as possible with those used in deriving the production data from Census statistics. Before applying the correction for exports, a reduction of 10 percent was made in the declared export value of industrial machinery to allow for export crating and railroad transportation to the point of export.

An attempt was also made to correct for changes in inventories from 1930 to date. Prior to 1930, data were not available for making a similar correction. This correction was small, with the exception of that during 1932 when shipments of industrial machinery were estimated to have been 7 percent more than its production (which was extremely low that year). In other years the correction, plus or minus, for inventory changes was less than 3 percent.

The net production of designated types of industrial machinery at factory prices remaining for domestic consumption was next adjusted for the differences between factory cost and the cost to the industrial purchaser. Adjustments were also made at this point for durable products that are used by manufacturing concerns but for which no precise allocation could be made of the proportion of the total product that was devoted to manufacturing-capital purposes. These adjustments include the following additions: (a) For distribution, transportation, and installation costs—17 percent; (b) for equipment used in the plant in which it was manufactured but which was not reported as a Census product—7 percent; (c) for other manufacturing-capital items, such as measuring instruments, mechanical power transmission equipment, industrial locomotives, power shovels, and brewery equipment, but for which complete detailed tabulations were not available in any but the most recent years—13 percent. This last figure was derived from a detailed study of items of this character for which specific data are available in the 1937 Census of Manufactures. Thus, industrial-machinery production at factory prices was increased by a total of 37 percent to secure capital expenditures by the industrial user. To this were added all imports of industrial machinery, with appropriate allowances for duty, transportation costs, insurance, and import commission. The resulting figure is an estimate of total capital expenditures for manufacturing equipment at the prices paid by the industrial user.

Plant Expenditures.

The estimates of plant expenditures include such items as buildings (together with elevators, heating, plumbing, and similar accessory equipment), blast furnaces, docks, boilers, pipe, stills, tanks and vats, and similar fixed structures.

Factory building construction is approximately four-fifths of the total estimated plant expenditures in most years. The principal basis for the factory building activity estimates are the reports of contract awards which the F. W. Dodge Corporation have compiled for 37 Eastern States in 1925 and subsequent years, 36 States in 1923 and 1924, and 27 States in earlier years. Allowances for the Pacific Coast and Rocky Mountain States not covered in any year by the Dodge reports, and for the Southeastern States not covered in the earlier years, were made through use of Engineering News-Record statistics of contracts awarded, together with data upon the relative rate of additions to facilities such as cotton spindles, woolen and worsted looms, petroleum refinery capacity, and other measures that are available for the country as a whole.

In order to estimate factory building construction in the textile and petroleum refining industries in Southeastern and South Central States in earlier years (not covered by the Dodge Corporation's reports), a special examination was made of gross changes in their production facilities. From this examination, ratios were obtained of the relative expansion in the Southern States and in the Dodge reporting area. These ratios were used to estimate the volume of factory building contracts for the industries under question located in the South. Particular attention to the textile and petroleum refining industries was necessary, since they experienced a marked expansion in the Southern area during this period.

Estimates of factory building in the Western States over the period from 1919 to 1940 were based upon the industrial building contracts reported by the Engineering News-Record. The statistics for industrial building contracts compiled by that publication included electric light and power buildings, railroad buildings, and some other structures not built by manufacturing concerns. Consequently a special tabulation of the contracts awarded in the Western States in each of 12 manufacturing industries, showing the largest projects separately, was made for this period. These special tabulations yielded data which were used to calculate quarterly estimates of factory building in the Western States.

A detailed examination of factory building projects of different industries in various States for selected years, using all available sources of information, indicated that the Dodge Corporation statistics include roughly 70 percent of all factory building construction in the areas covered by these reports. This percentage was consequently applied to the estimated contract totals for the United States in order to secure an estimate of total factory building construction upon which work was started in a given period.

The data in table 1 are designed to measure, both for plant and equipment, the value of the capital facilities that are actually being fabricated for manufacturing capital purposes during the period indicated. An examination of the time period required for the construction of various types of factory buildings indicated that contracts could be translated into current activity for a given time period by use of a moving average consisting of two-thirds the contracts awarded in the previous quarter and one-third of the contracts in the given quarter. This final adjustment gave the estimates of dollar value of factory building construction activity in the United States for each quarter during the period from 1915 to 1940.

Estimates of plant construction other than buildings were derived by allocating to manufacturing capital certain percentages of the value of products reported by the Bureau of the Census, of such items as tanks, vats, pipe, industrial boilers, and similar plant facilities used in manufacturing plants. These estimates were determined in the same manner as those of machinery production, with similar allowances for exports and imports and for distribution, transportation, and installation costs. The estimates of plant expenditures shown in table 1, then, include both the measures of building construction and the measures of plant construction other than buildings.

Many collateral examinations were made in the calculation of these estimates to test their reliability and consistency with other measures. Also, each series was examined carefully and an attempt made to eliminate all fluctuations in the basic data, not representative of the country as a whole, and to correct for any changes in the coverage of a series from time to time.

Nevertheless, estimates such as these, which are built up from many primary sources varying in coverage and quality and which in their calculation involve personal judgment, are subject to error and should be so recognized.

Consequently, persons who may care to make use of these estimates are advised not to attach too great significance to small fluctuations in the series. In earlier years the fluctuations from quarter to quarter in total capital expenditures may differ from those that actually occurred by possibly 15 percent. Since 1923, it is believed that these fluctuations are likely to be in error considerably less than that amount.

The absolute magnitude of this series depends in an important degree upon allowances for mark-up for equipment above factory prices and for installation and transportation costs, and allowances for under-reporting used in compiling the factory construction activity estimates. A preliminary examination of the statistics on plant and equipment expenditures of manufacturing concerns in a number of industries reporting to the Bureau of the Census in 1939 suggests that the data shown in table 1 may not differ greatly from the actual expenditures for manufacturing capital purposes in that year. Nevertheless, the estimates presented above should be regarded as preliminary and will be revised if necessary as soon as the census enumeration for 1939 has been completed.